1.0 Introduction

This Hanford Site environmental report is produced through the joint efforts of the principal site contractors (Pacific Northwest National Laboratory, Fluor Daniel Hanford, Inc. and its subcontractors, Bechtel Hanford, Inc. and its subcontractors, and MACTEC-ERS). This report, published annually since 1958, includes information and summary data that 1) characterize environmental management performance at the Hanford Site; 2) demonstrate the status of the site's compliance with applicable federal, state, and local environmental laws and regulations; and 3) highlight significant environmental monitoring and surveillance programs and projects.

Specifically, the report provides a short introduction to the Hanford Site and its history; discusses the current site mission; and briefly highlights the site's various waste management, effluent monitoring, environmental surveillance, and environmental compliance programs and projects. Included are summary data and descriptions for the Hanford Groundwater Monitoring Project, the Near-Facility Environmental Monitoring Program, the vadose zone characterization project, the Surface Environmental Surveillance Project, the Hanford Cultural Resources Laboratory, wildlife studies, climate and meteorological monitoring, and information about other programs and projects. Also included are sections discussing environmental occurrences, current issues and actions, environmental cleanup activities, compliance issues, and descriptions of major operations and activities. Readers interested in more detail than that provided in this report should consult the technical documents cited in the text. Descriptions of specific analytical and sampling methods used in the monitoring efforts are contained in the Hanford Site environmental monitoring plan (DOE/RL 91-50, Rev. 2).

1.0.1 Overview of the Hanford Site

The Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State (Figure 1.0.1). The site occupies an area of approximately 1,450 km^2 (approximately 560 mi^2) located north of the city of Richland and the confluence of the Yakima and Columbia Rivers. This large area has restricted public access and provides a buffer for the smaller areas onsite that historically were used for production of nuclear materials, waste storage, and waste disposal. Only approximately 6% of the land area has been disturbed and is actively used. The Columbia River flows eastward through the northern part of the Hanford Site and then turns south, forming part of the eastern site boundary. The Yakima River flows near a portion of the southern boundary and joins the Columbia River downstream from the city of Richland.

The cities of Richland, Kennewick, and Pasco (Tri-Cities) constitute the nearest population center and are located southeast of the site. Land in the surrounding environs is used for urban and industrial development, irrigated and dry-land farming, and grazing. In 1995, wheat represented the largest single crop in terms of area planted in Benton and Franklin Counties. Total acreage planted in the two counties was 100,770 and 18,810 ha (249,000 and 46,500 acres) for winter and spring wheat, respectively. Corn, alfalfa, potatoes, asparagus, apples, cherries, and grapes are other major crops in Benton and Franklin Counties. Several processors in Benton and Franklin Counties produce food products, including potato products, canned fruits and vegetables, wine, and animal feed.

Estimates for 1996 placed population totals for Benton and Franklin Counties at 131,000 and 43,700, respectively (Washington State Office of Financial Management 1996a). When compared to the 1990 census data (U.S. Bureau of the Census 1994) in which Benton County had 112,560 individuals and Franklin County's population totaled 37,473 individuals, the current population totals reflect the continued growth occurring in these two counties.

The 1996 estimates distributed the Tri-Cities' population within each county as follows: Richland 35,990, Pasco 22,370, and Kennewick 48,010. The combined populations of Benton City, Prosser, and West Richland totaled 13,665 in 1996. The unincorporated population of Benton County was 33,335. In Franklin County, incorporated areas (cities and towns) other than Pasco have a total

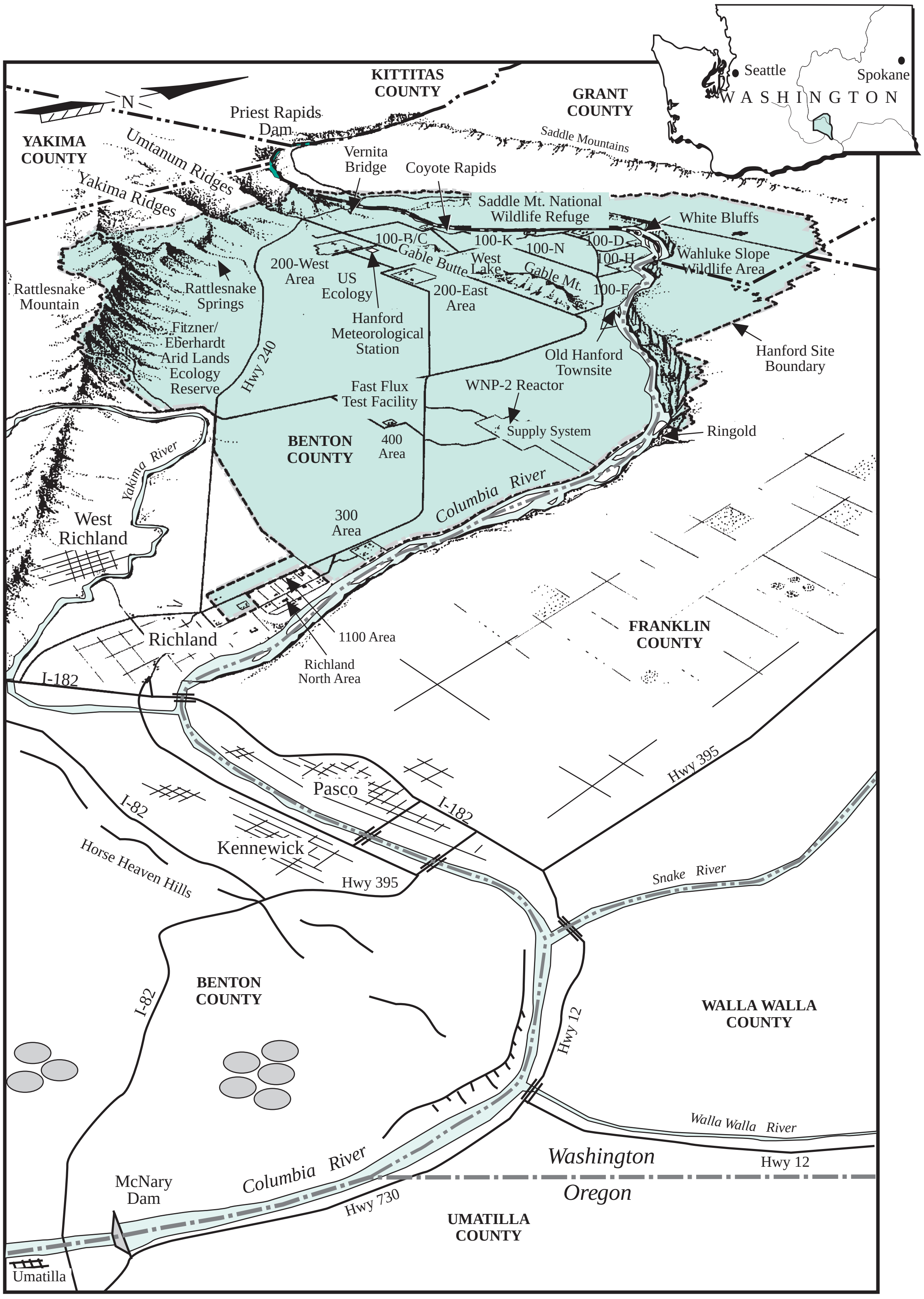

Figure 1.0.1. The Hanford Site and Surrounding Area

population of 3,263. The unincorporated rural population of Franklin County was 18,067 (Washington State Office of Financial Management 1996a).

The 1994 estimates of racial categories (Washington State Office of Financial Management 1996a) indicate that Asians represent a lower proportion and individuals of Hispanic origin represent a higher proportion of the racial distribution in Benton and Franklin Counties than those in Washington State.

Benton and Franklin Counties account for 3.2% of Washington State's population (Washington State Office of Financial Management 1996b). In 1996, the population demographics of Benton and Franklin Counties were quite similar to those found within Washington State. The population in Benton and Franklin Counties under the age of 35 was 54.5%, compared to 50.7% for the state. In general, the population of Benton and Franklin Counties was somewhat younger than that of the state. The 0- to 14-year-old age group accounted for 26.6% of the total bicounty population compared to 22.7% for the state. In 1996, the 65-year-old and older age group constituted 9.7% of the population of Benton and Franklin Counties compared to 11.5% for the state.

1.0.1.1 Site Description

The entire Hanford Site was designated a National Environmental Research Park (one of four nationally) by the former U.S. Energy Research and Development Administration, a precursor to U.S. Department of Energy (DOE).

The major operational areas on the site include the following:

- The 100 Areas, on the south shore of the Columbia River, are the sites of nine retired plutonium production reactors, including the dual-purpose N Reactor. The 100 Areas occupy approximately 11 km^2 (4 mi^2).

- The 200-West and 200-East Areas are located on a plateau and are approximately 8 and 11 km (5 and 7 mi), respectively, south of the Columbia River. The 200 Areas cover approximately 16 km^2 (6 mi^2).

- The 300 Area is located just north of the city of Richland. This area covers 1.5 km^2 (0.6 mi^2).

- The 400 Area is approximately 8 km (5 mi) northwest of the 300 Area.

- The 600 Area includes all of the Hanford Site not occupied by the 100, 200, 300, and 400 Areas.

- The 1100 Area is located generally between the 300 Area and the city of Richland, and includes site support services such as general stores and transportation maintenance.

- The Richland North Area (off the site) includes the DOE and its contractor facilities, mostly leased office buildings, generally located in the northern part of the city of Richland.

Other facilities (office buildings) are located in the Richland Central Area (located south of Saint Street and Highway 240 and north of the Yakima River), the Richland South Area (located between the Yakima River and Kennewick), and the Kennewick/Pasco area.

Several areas of the site, totaling 665 km^2 (257 mi^2), have special designations. These include the Fitzner/Eberhardt Arid Lands Ecology Reserve, the U.S. Fish and Wildlife Service Saddle Mountain National Wildlife Refuge, and the Washington State Department of Game Reserve Area (Wahluke Slope Wildlife Recreation Area). The Fitzner/Eberhardt Arid Lands Ecology Reserve was established in 1967 by the U.S. Atomic Energy Commission, a precursor to DOE, to preserve shrub-steppe habitat and vegetation. In 1971, the reserve was classified a Research Natural Area as a result of a federal interagency cooperative agreement. In June 1997, DOE transferred management, including access management, of the reserve from Pacific Northwest National Laboratory to the U.S. Fish and Wildlife Service. The Service will continue to operate the reserve using the current management policy (PNL-8506) until a new management plan can be written. This is scheduled to occur within 3 years of the June 1997 transfer date.

Non-DOE operations and activities on Hanford Site leased land or in leased facilities include commercial power production by the Washington Public Power Supply System (WNP-2 reactor) and operation of a commercial low-level radioactive waste burial site by US Ecology, Inc. Kaiser Aluminum and Chemical Corporation is leasing the 313 Building in the 300 Area to use an extrusion press that was formerly DOE owned. The National Science Foundation is building the Laser Interferometer Gravitational-Wave Observatory facility near Rattlesnake Mountain for gravitational wave studies. R. H. Smith Distributing operates vehicle-fueling stations in the 1100 and 200 Areas. Washington State University at Tri-Cities operates three laboratories in the 300 Area. Livingston Rebuild Center, Inc. has leased the 1171 Building, in the 1100 Area, to rebuild train locomotives. Johnson Controls, Inc. operates 42 diesel- and natural gas-fueled package boilers for producing steam in the 200 and 300 Areas (replacing the old coal-fired steam plants) and also has compressors supplying compressed air to the site. Immediately adjacent to the southern boundary of the Hanford Site, Siemens Power Corporation operates a commercial nuclear fuel fabrication facility and Allied Technology Group Corporation operates a low-level radioactive waste decontamination, super compaction, and packaging facility.

Much of the above information is from PNNL-6415, Rev. 9, where more detailed information can be found.

1.0.2 Historical Site Operations

The Hanford Site was established in 1943 to use technology developed at the University of Chicago and the Clinton Laboratory in Oak Ridge, Tennessee to produce plutonium for some of the nuclear weapons tested and used in World War II. Hanford was the first plutonium production facility in the world. The site was selected by the U.S. Army Corps of Engineers because it was remote from major populated areas and had 1) ample electrical power from Grand Coulee Dam, 2) a functional railroad, 3) clean water from the nearby Columbia River, and 4) sand and gravel that could be used for constructing large concrete structures. For security, safety, and functional reasons, the site was divided into numbered areas (see Figure 1.0.1).

Hanford Site operations have resulted in the production of liquid, solid, and gaseous wastes. Most wastes resulting from site operations have had at least the potential to contain radioactive materials. From an operational standpoint, radioactive wastes were originally categorized as "high level," "intermediate level," or "low level," which referred to the level of radioactivity present. Some high-level solid waste, such as large pieces of machinery and equipment, were placed onto railroad flatcars and stored in underground tunnels. Both intermediate- and low-level solid wastes, consisting of tools, machinery, paper, wood, etc., were placed into covered trenches at storage and disposal sites known as "burial grounds." Beginning in 1970, solid wastes were segregated according to the makeup of the waste material. Solids containing plutonium and other transuranic materials were packaged in special containers and stored in lined trenches covered with soil for possible later retrieval. High-level liquid wastes were stored in large underground tanks. Intermediate-level liquid waste streams were usually routed to underground structures of various types called "cribs." Occasionally, trenches were filled with the liquid waste and then covered with soil after the waste had soaked into the ground. Low-level liquid waste streams were usually routed to surface impoundments (ditches and ponds). Nonradioactive solid wastes were usually burned in "burning grounds." This practice was discontinued in the late 1960s in response to the Clean Air Act, and the materials were buried at sanitary landfill sites. These storage and disposal sites, with the exception of high-level waste tanks, are now designated as "active" or "inactive" waste sites, depending on whether the site currently is receiving wastes.

1.0.2.1 The 300 Area

From the early 1940s to the present, most research and development activities at the Hanford Site were carried out in the 300 Area, located just north of Richland. The 300 Area was also the location of nuclear fuel fabrication. Nuclear fuel in the form of pipe-like cylinders (fuel elements) was fabricated from metallic uranium shipped in from offsite production facilities. Metallic uranium was extruded into the proper shape and encapsulated in aluminum or zirconium cladding. Copper was an important material used in the extrusion process, and substantial amounts of copper, uranium, and other heavy metals ended up in 300 Area liquid waste streams. Initially, these streams were routed to the 300 Area waste ponds, which were located near the Columbia River shoreline. In more recent times, the low-level liquid wastes were sent to process trenches or shipped to a solar evaporation facility in the 100-H Area (183-H Solar Evaporation Basins). This practice has been discontinued.

1.0.2.2 The 100 Areas

The fabricated fuel elements were shipped by rail from the 300 Area to the 100 Areas. The 100 Areas are located on the shore of the Columbia River, where up to nine nuclear reactors were in operation (Section 6.1, "Hanford Groundwater Monitoring Project," discusses these operations). The main component of the nuclear reactors consisted of a large stack (pile) of graphite blocks that had tubes and pipes running through it. The tubes were receptacles for the fuel elements while the pipes carried water to cool the graphite pile. Placing large numbers of slightly radioactive uranium fuel elements into the reactor piles created an intense radiation field and a radioactive chain reaction resulted in the conversion of some uranium atoms into plutonium atoms. Other uranium atoms were split into radioactive "fission products." The intense radiation field also caused some nonradioactive atoms in the structure to become radioactive "activation products."

The first eight reactors, constructed between 1944 and 1955, used water from the Columbia River for direct cooling. Large quantities of water were pumped through the reactor piles and discharged back into the river. The discharged cooling water contained radioactive materials that escaped from the fuel elements, tube walls, etc. during the irradiation process. The radiation fields in the piles also caused some of the impurities in the river water to become radioactive (neutron activation). The ninth reactor, N Reactor, was completed in 1963 and was a slightly different design. Purified water was recirculated through the reactor core in a closed-loop cooling system. Beginning in 1966, the heat from the closed-loop system was used to produce steam that was sold to the Washington Public Power Supply System to generate electricity at the adjacent Hanford Generating Plant.

When fresh fuel elements were pushed into the front face of a reactor's graphite pile, irradiated fuel elements were forced out the rear into a deep pool of water called a "fuel storage basin." After a brief period of storage in the basin, the irradiated fuel was shipped to the 200 Areas for processing. The fuel was shipped in casks by rail in specially constructed railcars. Most of the irradiated fuel produced by the N Reactor from the early 1970s to the early 1980s was the result of electrical production runs. This material was not weapons grade, so was never processed for recovery of plutonium.

Beginning in 1975, N Reactor irradiated fuel was shipped to the KE and KW Fuel Storage Basins (K Basins) for temporary storage, where it remains today. This fuel accounts for the majority of the total fuel inventory currently stored under water in the K Basins. From the early 1980s until its shutdown in 1987, N Reactor operated to produce weapons-grade material. Electrical production continued during this operating period but was actually a byproduct of the weapons production program. The majority of weapons-grade material produced during these runs was processed in the 200-East Area at the Plutonium-Uranium Extraction Plant prior to its shutdown. The remainder is stored in the K Basins.

1.0.2.3 The 200 Areas

The 200-East and 200-West Areas are located on a plateau approximately 11 and 8 km (7 and 5 mi), respectively, south of the Columbia River. These areas house facilities that received and dissolved irradiated fuel and then separated out the valuable plutonium (Figure 1.0.2). These facilities were called "separations plants." Three types of separations plants were used over the years to process irradiated fuel. Each of the plutonium production processes began with the dissolution of the aluminum or zirconium cladding material in solutions containing ammonium hydroxide/ammonium nitrate/ammonium fluoride followed by the dissolution of the irradiated fuel elements in nitric acid. All three separations plants, therefore, produced large quantities of waste nitric acid solutions that contained high levels of radioactive materials. These wastes were neutralized and stored in large underground tanks. Fumes from the dissolution of cladding and fuel, and from other plant processes, were discharged to the atmosphere from tall smokestacks. Filters were added to the stacks after 1950.

Both B Plant and T Plant used a "bismuth phosphate" process to precipitate and separate plutonium from acid solutions during the early days of site operations. Leftover uranium and high-level waste products were not separated and were stored together in large underground "single-shell" tanks (i.e., tanks constructed with a single wall of steel). The leftover uranium was later salvaged, purified into uranium oxide powder at the Uranium-TriOxide Plant, and transported to uranium production facilities in other parts of the country for reuse. The salvage process used a solvent extraction technique that resulted in radioactive liquid waste that was discharged to the soil in covered trenches at the BC Cribs area south of the 200-East Area. Cooling water and steam condensates from B Plant went to B Pond, cooling water and steam condensates from T Plant went to T Pond, and cooling water and steam condensates from U Plant and the Uranium-TriOxide Plant were routed to U Pond.

After T Plant stopped functioning as a separations facility, it was converted to a decontamination operation where large pieces of equipment and machinery could be cleaned up for reuse. B Plant was later converted into a facility to separate radioactive strontium and cesium from high-level waste. The strontium and cesium were then concentrated into a solid salt material, melted, and

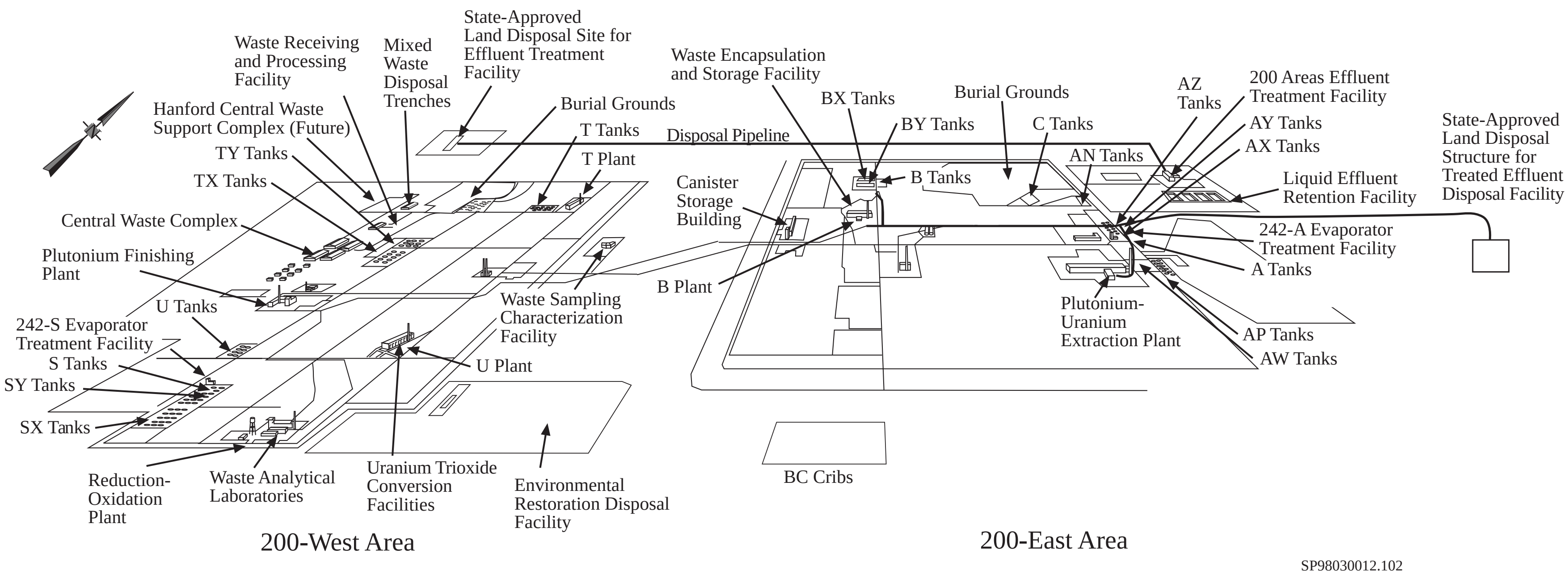

Figure 1.0.2. Waste Processing, Storage, and Disposal Facilities in the 200 Areas

encapsulated at the adjacent encapsulation facility. Canisters of encapsulated strontium and cesium were stored in a water storage basin at the encapsulation facility, where many remain today.

The Reduction-Oxidation Plant and Plutonium-Uranium Extraction Plant used solvent extraction techniques to separate plutonium from leftover uranium and radioactive waste products. Most of the irradiated fuel produced at the site was processed at either of these two plants. The solvent extraction method separates chemicals based on their differing solubilities in water and organic solvents (i.e., hexone at the Reduction-Oxidation Plant and tributylphosphate at the Plutonium-Uranium Extraction Plant). High-level liquid wastes were neutralized and stored in single-shell tanks (Reduction-Oxidation Plant) or double-shell tanks (Plutonium-Uranium Extraction Plant). Occasionally, organic materials such as solvents and resins ended up in high-level liquid waste streams sent to the tanks. Various chemicals and radioactive materials precipitated and settled to the bottom of the tanks. This phenomenon was later used to advantage. The liquid waste was heated in special facilities (evaporators) to remove excess water and concentrate the waste into salt cake and sludge, which remained in the tanks. The evaporated and condensed water contained radioactive tritium and was discharged to cribs. Intermediate- and low-level liquid wastes discharged to the soil from the Reduction-Oxidation and Plutonium-Uranium Extraction Plants typically contained tritium and other radioactive fission products as well as nonradioactive nitrate. Intermediate-level liquid wastes discharged to cribs from the Reduction-Oxidation Plant sometimes contained hexone used in the reduction-oxidation process. Cooling water from the Reduction-Oxidation Plant was discharged to the S Ponds. Cooling water from the Plutonium-Uranium Extraction Plant was discharged to Gable Mountain Pond and B Pond.

The Reduction-Oxidation and Plutonium-Uranium Extraction Plants produced uranium nitrate for recycle and plutonium nitrate for weapons component production. Uranium nitrate was shipped by tank truck to the Uranium-TriOxide Plant for processing. The Uranium-TriOxide Plant used specially designed machinery to heat the uranium nitrate solution and boil off the nitric acid, which was recovered and recycled to the separations plants. The product (uranium oxide) was packaged and shipped to other facilities in the United States for recycle. Plutonium nitrate, in small quantities for safety reasons, was placed into special shipping containers (P-R cans) and hauled by truck to Z Plant (later called the Plutonium Finishing Plant) for further processing.

The purpose of Plutonium Finishing Plant operations was to convert the plutonium nitrate into plutonium metal blanks (buttons) that were manufactured offsite into nuclear weapons components. The conversion processes used nitric acid, hydrofluoric acid, carbon tetrachloride, and other organic compounds. Varying amounts of all these materials ended up in the intermediate-level liquid wastes that were discharged to cribs. Cooling water from the Plutonium Finishing Plant was discharged via open ditch to U Pond. High-level solid wastes containing plutonium were segregated and packaged for storage in special earth-covered trenches.

1.0.2.4 The 400 Area

In addition to research and development activities in the 300 Area, the Hanford Site has supported several test facilities. The largest is the Fast Flux Test Facility located approximately 8 km (5 mi) northwest of the 300 Area. This special nuclear reactor was designed to test various types of nuclear fuel. The facility operated for approximately 13 years and was shut down in 1993. The reactor was a unique design that used liquid metal sodium as the primary coolant. The heated liquid sodium was cooled with atmospheric air in heat exchangers. Spent fuel from the facility resides in the 400 Area, while other wastes were transported to the 200 Areas. With the exception of the spent fuel, no major amounts of radioactive wastes were stored or disposed of at the Fast Flux Test Facility site. In January 1997, DOE made a decision to keep the Fast Flux Test Facility in standby while evaluating its potential for tritium and medical isotope production, as well as plutonium disposition. Tritium, a necessary ingredient in some nuclear weapons, decays relatively quickly so must be replenished. Medical isotopes are radioactive elements that are useful for the treatment of medical conditions such as cancer. Excess plutonium, no longer needed for national defense, could be disposed of by converting it to reactor fuel that could be burned in commercial reactors. A decision on these missions is expected by December 1998.

1.0.3 Current Site Mission

For more than 40 years, Hanford Site facilities were dedicated primarily to the production of plutonium for national defense and to the management of the resulting wastes. In recent years, efforts at the site have focused on developing new waste treatment and disposal technologies and cleaning up contamination left over from historical operations.

The current site mission includes the following:

- **management of wastes** and the handling, storage, treatment, and disposal of radioactive, hazardous, mixed, or sanitary wastes from past and current operations

- **stabilizing facilities** by transitioning them from an operating mode to a long-term surveillance and maintenance mode. This includes maintaining facilities in a safe and compliant status, deactivating primary systems to effectively reduce risks, providing for the safe storage of nuclear materials and reducing risks from hazardous materials and contamination. These activities are intended to allow the lowest surveillance and maintenance cost to be attained while awaiting determination of a facility's final disposition.

- **maintaining the Fast Flux Test Facility reactor** and its associated support facilities while alternative future missions for the reactor are explored (i.e., medical isotope and/or tritium production, plutonium disposition)

- **maintenance and cleanup** of several hundred inactive radioactive, hazardous, and mixed waste disposal sites (there are over 2,200 waste sites of all kinds at Hanford); remediation of contaminated groundwater; and **surveillance, maintenance, and decommissioning** of inactive facilities

- **research and development** in energy, health, safety, environmental sciences, molecular sciences, environmental restoration, waste management, and national security

- **developing new technologies** for environmental restoration and waste management, including site characterization and assessment methods; waste minimization, treatment, and remediation technology.

DOE has set a goal of cleaning up Hanford's waste sites and ensuring that its facilities are always in compliance with local, state, and federal environmental laws. In addition to supporting the environmental management mission, DOE is also supporting other special initiatives in accomplishing its national objective.

1.0.3.1 Site Policy for Protecting the Environment and Worker Safety and Health

The highest priority of the DOE Richland Operations Office is to achieve daily excellence in protection of the worker and the public and in stewardship of the environment, both on and off the Hanford Site. By meeting the most rigorous standards, the DOE Richland Operations Office provides safe and healthful workplaces and protects the environment of all Richland Operations activities. Fundamental to the attainment of this policy are personal commitment and accountability, mutual trust, open communications, continuous improvement, worker involvement, and full participation of all interested parties. Consistent with the strategic plan for the site (DOE/RL-96-92), the Richland Operations Office will reduce accidents, radiological and toxicological exposures, and regulatory noncompliances.

1.0.4 Site Management

Hanford Site operations and activities are managed by the DOE Richland Operations Office through the following contractors and subcontractors. Each contractor is responsible for safe, environmentally sound maintenance and management of its activities or facilities and operations; for waste management; and for monitoring operations and effluents to ensure environmental compliance.

The principal contractors and their respective responsibilities include the following:

- Fluor Daniel Hanford, Inc., the management and integration contractor, is the prime contractor under the Project Hanford Management Contract awarded in 1996. The Project Hanford Management Contract encompasses the majority of the work under way at the Hanford Site as it relates to DOE's mission to clean up the site. Major subcontractors of Fluor Daniel Hanford, Inc. and their areas of responsibility are as follows.

    - Lockheed Martin Hanford Corporation - responsible for tank waste remediation systems. With 177 underground waste containment tanks at the site, they ascertain the contents and evaluate treatment alternatives.

- Waste Management Federal Services of Hanford, Inc. - responsible for waste management. They use existing technology to accelerate treatment and disposal of waste, reduce the need for waste storage, and minimize waste disposition.

- DE&S Hanford, Inc. - responsible for the spent fuel project. This project addresses the cleanup efforts associated with the waste and fuel rods stored in the K Basins.

- B&W Hanford Company - responsible for the facility stabilization project and the Advanced Reactors Transition Project. The facility stabilization project is tasked with safely and cost effectively deactivating contaminated surplus facilities to a reduced cost, low-risk stabilized/ shutdown condition for either long-term surveillance and maintenance or final disposition. The Advanced Reactors Transition Project maintains the Fast Flux Test Facility and its associated support facilities in a safe and stable condition while DOE explores alternative future missions (i.e., medical isotope and/or tritium production).

- Numatec Hanford Corporation - responsible for technology implementation and nuclear engineering. They provide application technology as needed to all cleanup contractors.

- DynCorp Tri-Cities Services, Inc. - responsible for infrastructure services. They provide non-nuclear-related support in the areas of site operation, property management, utilities, facility maintenance, and site services.

• Battelle Memorial Institute, the research and development contractor, operates Pacific Northwest National Laboratory for DOE, conducting research and development in environmental restoration and waste management, environmental science, molecular science, energy, health and safety, and national security. In addition, the laboratory performs groundwater monitoring for the Hanford Groundwater Monitoring Project, which includes Resource Conservation and Recovery Act/ Comprehensive Environmental Response, Compensation, and Liability Act monitoring and surface environment surveillance both on and around the site.

• Bechtel Hanford, Inc., the environmental restoration contractor is responsible for surveillance and maintenance of inactive past-practice waste sites and inactive facilities; remediation of past-practice waste sites and contaminated groundwater; closure of Resource Conservation and Recovery Act land-based treatment, storage, and disposal units; decontamination and decommissioning of facilities; overall Hanford Site groundwater project management; and sitewide drilling management. The Bechtel Team includes two preselected subcontractors: CH2M Hill Hanford, Inc. and ThermoHanford, Inc.

• Hanford Environmental Health Foundation is the occupational and environmental health services contractor.

• MACTEC-ERS is a prime contractor to DOE Grand Junction Office and is performing vadose zone characterization and monitoring work beneath single-shell underground waste storage tanks in the 200 Areas.

In addition, several enterprise companies were created to provide services to Fluor Daniel Hanford, Inc. These subcontractors and their areas of responsibility include the following:

• B&W Protec, Inc. provides safeguard and security services, including material control and accountability, physical security, information security, and other security activities.

• COGEMA Engineering Corporation provides engineering and technical support in the areas of tank waste remediation systems engineering and construction, spent fuel conditioning, and engineering testing and technology.

• Lockheed Martin Services, Inc. provides telecommunications and network engineers, information systems, production computing, document control, records management, and multimedia services.

• Fluor Daniel Northwest, Inc. provides a variety of professional services to the subcontractors, including construction, engineering, finance, accounting, and materials management.

• DE&S Northwest, Inc. provides nuclear and non-nuclear services in the area of quality assurance and related activities.

• Waste Management Federal Services, Inc., Northwest Operations provides waste transportation services, waste packaging systems engineering, environmental monitoring and investigations, groundwater well services, sampling and mobile laboratory services, and nuisance wildlife and vegetation management.

British Nuclear Fuels Limited, Inc., has contracted with DOE for Phase I, Part A of the Tank Waste Remediation System Privatization Project (September 26, 1996 - May 25, 1998). Contract deliverables include development of technical, operational, regulatory, business, and financial plans to provide treatment and immobilization services to process tank waste under Part B of the contract. If Part B of the contract is awarded in fiscal year 1998, the contractor will provide privatized services to process an initial portion of Hanford's tank waste.

1.0.5 Major Operations and Activities

1.0.5.1 Waste Management

Current waste management activities at the site include the management of high- and low-level defense wastes in the 200-East and 200-West Areas (see Figure 1.0.2) and the storage of irradiated fuel in the 100-K Area. Major facilities are discussed below.

Waste management activities involving single-shell and double-shell tanks currently include ensuring safe storage of wastes through surveillance and monitoring of the tanks, upgrading monitoring instrumentation, and imposing strict work controls during intrusive operations. Concerns had been raised about the potential for explosions from ferrocyanide and/or organic fuels or hydrogen gas accumulation in the waste tanks. DOE and external oversight groups have concluded that there is no imminent danger to the public from either situation. Lockheed Martin Hanford Corporation has the responsibility to identify any hazards associated with the waste tanks and to implement the necessary actions to resolve or mitigate those hazards.

The 40-year-old K Basins are currently being used to store N Reactor irradiated fuel. In 1995, the strategy for transitioning irradiated fuel from wet storage in these basins to dry interim storage in the 200-East Area was further developed. This strategy supports completion of fuel removal from the K Basins by the target date of December 2002 (agreed to by DOE and the regulators). At the end of 1997, construction of the Canister Storage Building for dry interim storage was nearly complete.

The 242-A Evaporator concentrates dilute liquid tank wastes by evaporation. The volume of tank wastes is reduced to eliminate the need to construct additional storage tanks and to minimize the volume of liquid in the tanks. The process condensate from the 242-A Evaporator and other liquid effluents are temporarily stored in the Liquid Effluent Retention Facility. This facility consists of three Resource Conservation and Recovery Act-compliant surface impoundments and provides flow and pH equalization. The wastewater from the Liquid Effluent Retention Facility is treated in the Effluent Treatment Facility to remove toxic metals, radionuclides, and ammonia and to destroy organics. The treated effluent has been delisted from the Resource Conservation and Recovery Act and is discharged to a state-approved land disposal site north of the 200-West Area under a state discharge permit (Washington Administrative Code [WAC] 173-216). The 200 Areas Treated Effluent Disposal Facility is a collection and disposal system for non-Resource Conservation and Recovery Act-permitted waste streams that already meet discharge requirements. The liquid effluents are routed to another state-approved land disposal site near the 200-East Area and discharged under a separate state discharge permit (WAC 173-216).

Wastewater in the 300 Area that is nonradioactive and nonhazardous is received via the process sewer and treated in the 300 Area Treated Effluent Disposal Facility. The wastewater is treated to remove heavy metals and cyanide and to destroy organics. Potentially contaminated wastewater in the 300 Area is collected, monitored for radioactive contamination, and transferred to the 300 Area Treated Effluent Disposal Facility. Radioactive liquid waste in the 300 Area is collected and transferred by railcar to double-shell underground waste storage tanks in the 200-East Area.

Solid waste is received at the Central Waste Complex from all radioactive waste generators at the Hanford Site and any offsite generators authorized by DOE to ship waste to the Hanford Site for treatment, storage, and disposal. The waste received at the Central Waste Complex is generated by ongoing site operations and research and development activities conducted at the site. Offsite waste has been primarily from DOE research facilities and other DOE sites. In addition, submarine reactor compartments are being received from the United States Navy for disposal. The characteristics of the waste received at the

Central Waste Complex vary greatly, from waste that is nondangerous solid low-level waste to solid transuranic mixed waste.

The planned capacity of the Central Waste Complex to store low-level waste and transuranic mixed waste is 15,540 m^3 (20,330 yd^3). This capacity is adequate to store the current projected volumes of mixed waste to be generated through at least the year 2003, assuming on-schedule treatment of the stored waste. Current plans call for treatment of the mixed waste to begin in 1999, which will reduce the amount of waste in storage and make storage room available for newly generated mixed waste. The majority of waste shipped to the Central Waste Complex is generated in small quantities by routine plant operation and maintenance activities. The dangerous waste designation of each container of waste is determined at its point of generation based on process knowledge of the waste placed in the container or on sample analysis if sufficient process knowledge is unavailable.

The newly constructed Waste Receiving and Processing Facility (operations began in March 1997) has the capability to process retrieved suspect transuranic solid waste (waste that may or may not meet transuranic criteria), certify newly generated and stored transuranic solid and low-level wastes for either disposal or shipment to the Waste Isolation Pilot Plant in New Mexico (transuranic only), and process small quantities of radioactive mixed low-level waste for permanent disposal. Current funding only addresses low-level waste processing. These capabilities are in accordance with land disposal restrictions and Hanford Site disposal criteria for low-level waste and in accordance with waste acceptance and transportation criteria for transuranic waste.

Two operational facilities are in the T Plant area: the T Plant canyon building used for waste verification, radiological decontamination of large equipment, and storage of pressurized water reactor spent fuel from a reactor in Shippingport, Pennslyvania; and the 2706-T facility used for waste verification, repackaging radioactive wastes, and small equipment decontamination. Other activities that can be done in T Plant are land disposal restriction determination for mixed waste soils, stabilization of toxic characteristic regulated soils, macroencapsulation of debris and contaminated equipment, neutralization and solidification of inorganic labpacks, and neutralization and repackaging of organic labpacks (specially packaged dangerous waste that may or may not originate from a laboratory).

The Environmental Restoration Disposal Facility, near the 200-West Area, was opened in July 1996 to accept waste generated during the Hanford Site cleanup activities. This facility serves as the central disposal site for contaminated soil and other waste removed under the Environmental Restoration Program. Additional details about the Environmental Restoration Disposal Facility are provided in Section 1.0.5.3, "Environmental Restoration" and in Section 2.2, "Compliance Status," regarding Comprehensive Environmental Response, Compensation, and Liability Act compliance.

1.0.5.2 Facility Stabilization

The Facility Stabilization Project's mission is to transition those Hanford Site facilities for which it has responsibility from an operating mode to a long-term surveillance and maintenance mode. This includes maintaining facilities in a safe, compliant status, providing for the safe storage of nuclear materials and reducing risks from hazardous materials and contamination. Under the project, the deactivation of primary systems to effectively reduce risks to human health and the environment will also be conducted. These activities will allow the lowest surveillance and maintenance costs to be attained while awaiting determination of a facility's final disposition and possible turnover to the DOE Environmental Restoration Program.

Currently, the Facility Stabilization Project is engaged in five major deactivation efforts at Hanford. The major efforts are the Plutonium-Uranium Extraction Plant, the Facility Stabilization and Environmental Restoration (FASTER) Team, the 300 Area Stabilization Project, the B Plant/Waste Encapsulation and Storage Facility, and the Plutonium Finishing Plant. (The FASTER Team is always referred to by its acronym.)

The Plutonium-Uranium Extraction Plant formerly processed irradiated fuel to extract plutonium and uranium. Plant operations were discontinued in 1989. A final stabilization run was conducted in early 1990 to process the fuel remaining in the plant and then the facility was transitioned to a standby condition. In 1992, DOE directed the plant's deactivation and transition to a surveillance and maintenance condition. Facility deactivation was completed in May 1997 and the plant is currently unoccupied, locked, and maintained under surveillance while awaiting eventual decontamination and decommissioning.

The FASTER Team provides comprehensive cleanup expertise and lessons learned from Plutonium-Uranium Extraction Plant deactivation to similar projects. This expertise is used in supporting the deactivation of several facilities at Hanford, primarily isolated facilities without associated staff. The FASTER Team is also involved with deactivation planning for DOE facilities at the Rocky Flats Plant in Colorado, the Savannah River Site in South Carolina, and the Brookhaven National Laboratory in New York.

The 300 Area Stabilization Project currently has two subprojects, the 300 Area Fuel Supply Shutdown Subproject and the 324/327 Building Transition Subproject. The 300 Area Fuel Supply Shutdown Subproject included buildings that date back to 1943 that housed manufacturing equipment for the production of fuel for the Hanford reactors. These production operations were discontinued in 1987 when N Reactor was shut down and placed in a stand-by mode. The 324/327 Building Transition Subproject includes the 324 and 327 Buildings, which were constructed in 1966 and 1953, respectively. These buildings house hot cells used for radiological research and development work. Both facilities were transferred to the Facility Stabilization Project in 1996.

B Plant went into service in 1944 to recover plutonium in a chemical separation process. Following the advent of the more efficient Plutonium-Uranium Extraction process, B Plant's mission was modified to recover the high-heat isotopes (primarily cesium-137 and strontium-90) from highly radioactive waste. The Waste Encapsulation and Storage Facility, a part of the B Plant complex, began operation in 1974 to encapsulate the recovered cesium and strontium and to provide safe interim storage for the capsules. In October 1995, DOE directed that B Plant be deactivated. This deactivation order did not include the Waste Encapsulation and Storage Facility, which will remain in service following the shutdown and deactivation of B Plant. The current mission is to place B Plant into a configuration suitable for long-term surveillance, pending final disposition while establishing the Waste Encapsulation and Storage Facility as a stand-alone facility capable of independent operation following B Plant shutdown and deactivation.

The Plutonium Finishing Plant operated from 1951 until 1989 to produce plutonium metal and oxide for defense use and to recover plutonium from scrap materials. In 1996, DOE issued a shutdown order for the Plutonium Finishing Plant, authorizing deactivation and transition of the plutonium processing portions of the facility. An environmental impact statement record of decision with a supplementary analysis for an improved method of immobilization of plutonium was approved in 1997 (DOE/EIS-0244-FS/SA1).

1.0.5.3 Environmental Restoration

Environmental Restoration Project activities include decontamination and decommissioning of inactive facilities, surveillance and maintenance of deactivated facilities, transition of deactivated facilities and waste sites to the Environmental Restoration Program, characterization and cleanup of inactive waste sites, monitoring and remediation of contaminated groundwater, and management of remediation waste.

The decontamination and decommissioning project conducts final disposition of inactive surplus facilities in a manner consistent with remedial actions conducted within adjacent or nearby waste sites. A primary responsibility for the decontamination and decommissioning project is interim safe storage of inactive reactor facilities. In 1997, placing the 46-year-old C Reactor in a safe storage mode was nearly half finished. When the work is finished in 1998, C Reactor will be the first production reactor in the DOE complex to be placed in safe storage inside a significantly smaller, safer facility. The safe-storage enclosure is intended to protect the environment from contaminants in the reactor core for up to 75 years or until final disposition. In late 1997 and early 1998, work was accelerated, and the northwest and southwest portions of the reactor building have been demolished.

The Surveillance/Maintenance and Transition Project performs surveillance and maintenance of inactive facilities until final disposition activities commence. The project also provides for the transition of facilities and waste sites into the Environmental Restoration Program after deactivation is complete. The project includes the radiation area remedial action program, which is responsible for the surveillance, maintenance, and decontamination or stabilization of approximately 800 inactive waste sites on the Hanford Site. These include cribs, ponds, ditches, trenches, unplanned release sites, and burial grounds. These sites are maintained by performing periodic surveillances, radiation surveys, herbicide applications and by initiating timely responses to identified problems. The overall objective of this project is to maintain these sites in a safe and stable configuration until final remediation strategies are identified and implemented. The main focus of this objective is to prevent the contaminants contained in these sites from spreading in the environment.

The Remedial Action Project is responsible for conducting the actual cleanup of contaminated inactive waste sites.

The DOE Richland Operations Office Groundwater Management Project is responsible for monitoring and remediating contaminated groundwater resulting from past releases at inactive waste sites and other Hanford Site operations, overall site groundwater project management, and sitewide drilling management.

In 1997, groundwater management personnel completed installation of the final two pump-and-treat systems (operable units 100-HR-3 and 100-KR-4 in the 100-H and 100-K Areas). These systems were originally identified by Hanford Site regulators and stakeholders as necessary to contain chromium-contaminated groundwater plumes. If these plumes, comprising hundreds of millions of liters (gallons) of groundwater, remained unchecked, contaminant levels in the groundwater moving toward the Columbia River could pose an unacceptable level of risk. Currently, five pump-and-treat systems hydraulically control the movement of groundwater by pumping it to the surface, treating it through a series of systems to remove contaminants, and then injecting it back into the aquifer. The removed contaminants are then safely disposed at permitted sites, such as the Environmental Restoration Disposal Facility. Supplementing the pump-and-treat systems are three vapor extraction units, which are used to remove carbon tetrachloride (a toxic industrial solvent) from the Hanford Site's underground environment.

During 1997, groundwater management personnel worked closely with regulators and stakeholders to better define the potential impact of Hanford Site groundwater on the Columbia River ecosystem. Project personnel provided significant assistance in preparing the Columbia River comprehensive impact assessment screening advisory report that is expected to be completed in 1998.

The Environmental Restoration Disposal Facility was opened in July 1996 to accept waste generated during Hanford Site cleanup activities. The waste volumes of contaminated materials significantly escalated in 1997 when cleanup work at two new sites near the D and DR Reactors and in the 300 Area began. After a full year of remedial action and disposal activities, the Environmental Restoration Disposal Facility's first two disposal cells were half full. The amount of waste disposed is tracking closely with projections. Given the rate at which waste is being disposed and the volume of waste that remains in the soil underlying the site, a plan for facility expansion was put into place. Regulator and stakeholder comments on the plan were obtained, and the Environmental Restoration Disposal Facility expansion was intitiated. Engineering design has started, with construction scheduled to begin in 1998.

1.0.5.4 Research and Technology Development

Research and technology development activities are conducted in the 200, 300, 400, and Richland North Areas. Many of these activities are intended to improve the techniques and reduce the costs of waste management, cleanup, environmental protection, and site restoration.

Surface barrier testing and monitoring continue at the Hanford Site. The Environmental Restoration Program constructed a prototype surface barrier in 1994, which is now in its third year of rigorous testing. The major phase of testing was completed in September 1997. The barrier is intended to prevent intrusion of water into underground waste and covers an actual waste crib located in the 200-BP-1 Operable Unit in the 200-East Area. Despite 2 years of abovenormal precipitation and an imposed irrigation treatment (totaling three times the long-term average precipitation), there has been no net infiltration (drainage) of water through the soil barrier. Vegetation established on the surface of the barrier has been effective in removing all available precipitation and test water. The barrier has been stable, exhibiting no settlement during the 2 years of testing. Wind and water erosion and biotic intrusion also have been minimal. The only measurable erosion occurred during the first 3 months of operation, when soil surfaces were bare. In contrast to barrier soil surfaces, gravel and rock side slopes, which are nearly free of vegetation, have experienced significant drainage. While advective drying of the rock surfaces has reduced drainage well below that which was expected, the drainage has amounted to 40% or more of the winter precipitation. Barrier testing suggests that vegetation on the side slopes may be important for final design. Monitoring studies will continue through 1998 to document water balance parameters, erosion losses, biotic intrusion, and side slope performance.

Initial field testing of an in situ groundwater cleanup technology, called redox manipulation, was performed during 1995. An injectable redox barrier using sodium dithionite as the reductant was successfully tested in the 100-H Area to address chromate contamination. During 1997, monitoring activities at the in situ redox manipulation field site continued with favorable results. Oxygen and hexavalent chromium have remained below detection limits in the test zone for more than 2.5 years following the test injection. Concentrations of mobilized trace metals and sulfate have also continued to decrease during this time and are below all applicable standards. During 1998, monitoring of the site will continue and treatability tests will be conducted at the 100-D Area.

DOE's tanks focus area tested and demonstrated a mobile robotic system, called the light-duty utility arm. This system can position a variety of scientific instruments, cameras, and small-scale retrieval devices within the underground radioactive waste storage tanks. The arm was officially transferred from the developers to the first set of users, the Tanks Waste Remediation System Characterization Program in September 1996. In September 1996, the arm was deployed into tank 241-T-106 with a high-resolution stereographic video system to inspect the tank dome, risers, and walls. Valuable inspection data were recorded. In addition to its uses at the Hanford Site, the system will be used for studies at two other DOE sites: the waste heel removal project at the Idaho National Engineering and Environmental Laboratory and the gunite and associated tanks treatability study at Oak Ridge National Laboratory.

The light-duty utility arm will be used as part of the Hanford Site tanks initiative. By the year 2000, this initiative is scheduled to 1) retrieve hard heel (solid) waste from tank 241-C-106 and establish retrieval performance criteria, 2) develop retrieval performance criteria supporting readiness to close single-shell tanks, 3) demonstrate characterization technologies, 4) demonstrate alternate retrieval technologies, and 5) establish risk/performance data for waste retrieval options. This project was formed by the tanks focus area and Tank Waste Remediation System.

The laser ablation/mass spectrometer system uses a chemical analysis method that can determine the amount of most elemental/isotopic constituents in tank waste samples without sample preparation. Developed and produced by the Pacific Northwest National Laboratory, Westinghouse Hanford Company, and ICF Kaiser Hanford Company, this tool will reduce the time and costs required to analyze tank waste core samples. The system was deployed in an analytical chemistry laboratory hot cell at the Hanford Site in September 1996 and its use continued in 1997.

Interim safe storage activities at the C Reactor are providing a stage for showcasing innovative decontamination and decommissioning technologies. At least 20 technologies and approaches will be field tested to demonstrate safer, less expensive, and more efficient ways of decommissioning aging nuclear facilities. In 1997, 11 of these innovative or improved technologies were demonstrated. Eight have since been adopted, replacing baseline technologies. Four of these technologies have been deployed at other Hanford projects and at other DOE facilities. One has been selected for use at the Chornobyl Reactor in Ukraine.

1.0.6 Site Environmental Programs

1.0.6.1 Effluent Monitoring, Waste Management, and Chemical Inventory Programs

Liquid and airborne effluents are monitored or managed through contractor effluent monitoring programs. These programs are designed to monitor effluents at their point of release into the environment whenever possible. Waste management and chemical inventory programs document and report the quantities and types of solid waste disposed of at the Hanford Site and the hazardous chemicals stored across the site. Results for the 1997 effluent monitoring and waste management and chemical inventory programs are summarized in Section 2.5, "Waste Management and Chemical Inventories," and Section 3.1, "Facility Effluent Monitoring."

1.0.6.2 Near-Facility Environmental Monitoring Program

This program provides facility-specific environmental monitoring immediately adjacent to onsite facilities. Monitoring is conducted to comply with DOE and contract requirements and local, state, and federal environmental regulations. The program is also designed to evaluate the effectiveness of effluent treatments and controls and waste management and restoration activities and to monitor emissions from diffuse/fugitive sources. Results for the 1997 programs are summarized in Section 3.2, "Near-Facility Environmental Monitoring." The Hanford Environmental Restoration Contractor will be negotiating to cut back on near-field monitoring in the 100-N Area based on upcoming deactivation (July 1998) and no change in monitoring data obtained over the past 10 years.

1.0.6.3 Sitewide Environmental Surveillance

The main focus of the sitewide environmental surveillance program is on assessing the impacts of radiological and chemical contaminants on the environment and human health and confirming compliance with pertinent environmental regulations and federal policies. Surveillance activities are conducted both on and off the site to monitor for contaminants from the entire Hanford Site rather than from specific contractor-owned or -managed facilities. Results for the 1997 sitewide environmental surveillance program are summarized in Section 4.0, "Environmental Surveillance Information."

1.0.6.4 Groundwater Monitoring and Vadose Zone Baseline Characterization

Extensive groundwater monitoring is conducted onsite to document the distribution and movement of groundwater contamination, to assess the movement of contamination into previously uncontaminated areas, to protect the unconfined aquifer from further contamination, and to provide an early warning when contamination of groundwater does occur. Sampling is also conducted to comply with state and federal requirements. A description of the monitoring program and a summary of the monitoring results for 1997 are described in Section 6.1, "Hanford Groundwater Monitoring Project."

Vadose zone baseline characterization is being conducted to establish baseline levels of manmade radionuclides in the vadose zone beneath the single-shell tanks in the 200 Areas and beneath selected cribs and trenches used for waste disposal. The primary objective of these efforts is to detect and identify gamma-emitting radionuclides and determine their concentrations and distributions. Results for the vadose zone characterization activities in 1997 are summarized in Section 6.2, "Vadose Zone Characterization and Monitoring."

1.0.6.5 Other Environmental Programs

Other aspects of the environment are studied for reasons other than specific impacts from possible contamination. These aspects include climate, wildlife, and cultural resources. These studies are summarized in Section 7.0, "Other Hanford Site Environmental Programs."